#11

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A system for extracting information from a complex signal, comprising:

a decomposition module disposed to derive a snapshot of input signal components from said complex signal;

a memory storing reference snapshots of signal components characterizing recognized states of said complex signal; and

an empirical modeling engine applying a similarity operator to said input signal components against said reference snapshots to generate at least one similarity measure as a function of elemental similarity values between corresponding components of the input snapshot and the reference snapshot according to a mapping into an expected range for a component, said similarity measure providing information about the state of said complex signal.

2. (Original) A system for extracting information as in claim 1, wherein said decomposition module derives each said snapshot from said complex signal using wavelet analysis to decompose said complex signal into a plurality of component coefficients.

3. (Original) A system for extracting information as in claim 1, wherein said decomposition module comprises a plurality of frequency filters for filtering said complex signal to derive said snapshot of input signal components.

Claims 4 – 5 (Cancelled)

6. (Original) A system for extracting information as in claim 1, wherein said complex signal is a communication signal, said system further comprising a lookup table, said empirical modeling engine matching said snapshot with a reference snapshot in said memory based on the at least one similarity measure, said matching reference snapshot identifying an entry in said lookup table, said identified lookup table entry being presented as an output of said system.

7. (Original) A system for extracting information as in claim 1, wherein said signal is generated from a system being monitored and said empirical modeling engine generates expected values for at least one of the signal components of said complex signal based on the at least one similarity measure, said system further comprising:

an adder for combining an expected value and a corresponding signal component and determining a residual value therefrom; and

a test unit for determining a deviation based on the residual.

8. (Original) A system for extracting information as in claim 7, further comprising a diagnostic unit responsive to deviation determinations from said test unit for generating a diagnosis of a condition in the operation of the monitored system.

9. (Original) A system for extracting information as in claim 7, wherein said test unit applies a threshold to the residual to determine a deviation.

10. (Original) A system for extracting information as in claim 7, wherein said test unit applies a sequential probability ratio test to a sequence of values of the residual to determine a deviation.

11. (Original) An apparatus for monitoring the operating condition of a system, comprising:

sensor means for acquiring a time-varying signal characterizing operation of the system; means for decomposing said time-varying signal into a plurality of components;

a memory for storing a plurality of reference snapshots of component values for known operating conditions; and

processor means responsive to the decomposing means, disposed to generate estimates of the components using a similarity operation on the component values from the decomposing means with reference to the component values in each reference snapshot in the memory, and further disposed to generate residual values by differencing the component values and the estimates thereof, for determination of deviating operating conditions of the system.

12. (Original) An apparatus according to claim 11, wherein said processor means is further disposed to perform a sequential probability ratio test on successive residual values for determining deviating operating conditions of the system.

13. (Original) An apparatus according to claim 11, wherein said processor means generates said estimates using a similarity operator in which a difference between two values is normalized with an expected range for said values.

Claims 14 - 18 (Cancelled)

19. (Currently Amended) A method for providing a reference library of representative sets of correlated values for use in monitoring a system using an empirical model, comprising the steps of:

receiving a variable signal measuring a parameter of said system during operation of said system in a known mode;

decomposing said variable signal into component signals;

sampling said component signals periodically to provide successive sets of correlated values; and

selecting some of said sets of correlated values for inclusion in said reference library and including a particular set of correlated values if said particular set includes a minimum or

a maximum value of one of the correlated values, as compared to all like values in all the sets of correlated values.

20. (Original) A method according to claim 19, wherein said decomposing step comprises transforming said variable signal with a discrete wavelet transformation to produce component signals comprising successive wavelet coefficients.

21. (Original) A method according to claim 19, wherein said decomposing step comprises filtering said variable signal with a plurality of frequency bandpass filters to produce component signals for each band of frequencies.

22. (Original) A method according to claim 19, further comprising storing in said reference library a classification with a selected set of correlated values, associated with a known state of the variable signal.

Claims 23 - 28 (Cancelled)

29. (Currently Amended) A method of extracting information from a complex signal, said method comprising the steps of:

a) receiving a complex signal, said complex signal carrying data therein;

b) periodically decomposing said received complex signal into a plurality of components;

c) comparing for similarity said components against a plurality of snapshots in a storage set of historical components, by rendering a value for each pair of corresponding components as a function of the difference between the pair and as a function of the expected range of variation for such component;

d) averaging comparison results from comparing said components against said snapshots, said average comparison results providing an indication of information in said complex signal.

30. (Original) A method of extracting information as in claim 29, wherein the step (b) of periodically decomposing said received complex signal comprises extracting wavelet detail levels from said complex signal.

31. (Original) A method of extracting information as in claim 29, wherein the comparison step (c) comprises applying a bounded area ratio test to each of said plurality of components, each component being compared against a corresponding component in each of the plurality of snapshots.

32. (Original) A method of extracting information as in claim 31, said method further comprising the steps of:

e) identifying a matching historical signature vector among said plurality of snapshots responsive to said average comparison results; and

f) outputting a digital result corresponding to said identified matching historical signature vector.

33. (Original) A method of extracting information as in claim 31, said complex signal being generated responsive to a system being monitored, said method further comprising the steps of:

e) generating an expected signal result from averaged said comparison results;

f) generating a residual from said expected signal result and said decomposed received complex signal; and

g) testing said residual to determine whether said expected signal result is different from said received complex signal.

34. (Original) A method of extracting information as in claim 33 further comprising the step of:

h) diagnosing a state of said monitored system responsive to said determination of step (g).

35. (New) An apparatus according to claim 11 wherein said sensor means measures vibration of said system.

36. (New) An apparatus according to claim 11 wherein said sensor means measures acoustic energy given off of said system.

37. (New) An apparatus according to claim 11 wherein said sensor means measures electric current used in said system.

38. (New) An apparatus according to claim 11, wherein said processor means is further disposed to determine whether a residual value exceeds a threshold for determining deviating operating conditions of the system.

39. (New) An apparatus according to claim 13, wherein the similarity operation determines similarity between snapshots of component values as a function of the Euclidean distance of the snapshots.

40. (New) A method for monitoring the operating condition of a system, comprising the steps of:

acquiring a time-varying signal characterizing operation of the system;

periodically extracting observations of features from said time-varying signal;

generating estimates for at least one of the extracted features responsive to extracting an observation of features, using a similarity operation with reference to a stored library of feature observations characteristic of acceptable operation of said system;

differencing at least one of said feature estimates with corresponding extracted features to produce residuals for determination of deviating operating conditions of said system.

41. (New) A method according to claim 40, further comprising the step of determining whether at least one of said residuals exceeds a threshold.

42. (New) A method according to claim 40, further comprising the step of performing a sequential probability ratio test on at least one of said residuals.

43. (New) A method according to claim 40, where said estimate generating step uses a similarity operation that normalizes a comparison of corresponding values of a feature from two feature observations with an expected range of variation for that feature.

44. (New) A method according to claim 40, wherein the step of extracting features includes generating a power spectral density function for said time-varying signal.

45. (New) A method according to claim 40, wherein the step of extracting features includes determining wavelet coefficients for said time-varying signal.

46. (New) A method according to claim 40, further comprising the step of providing said stored library of feature observations by selecting from previously acquired feature data of said system at least those observations wherein a feature value represents either the largest or smallest value for that feature across the previously acquired feature data.